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ABSTRACT

The Mathematics Pentathlon is a tournament of mathematics games held each spring since 1979 to promote the development of mathematical concepts and skills while fostering interaction among the educational community. There are five games in each of four divisions, for grades K-1, 2-3, 4-5, and 6-7. The focus is on active problem solving and critical thinking skills for children at different ability levels. This manual for grades 2-3 first discusses problem solving, educational community involvement, the range of academic performance, and the use of physical models. Then each game is described, with mathematical content, materials, time, goals, starting procedures, game rules, and tournament rules stated, plus a reproduction of the gameboard. The games for this level are Fiar, Sum Dominoes and Dice, Ramrod, Par 55, and Kwatro-Sinko. (MNS)

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A MANUAL OF DIRECTIONS AND OFFICIAL TOURNAMENT RULES

SUM DOMINOES & DICE

FIAR

RAMROD

KWATRO-SINKO

PAR 55

ED277577

DIVISION II
Grades 2-3

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CENTER FOR DISSEMINATION OF INNOVATIVE PROGRAMS

The Mathematics Pentathlon® provides recognition of those mathletes who have been successful in competing with others. The real winning spirit, however, is best exemplified by the ability of a Mathlete™ to congratulate an opponent on a game well played regardless of the outcome.

MATHEMATICS PENTATHLON®

A MANUAL OF
DIRECTIONS
AND
OFFICIAL TOURNAMENT RULES

DIVISION II
Grades 2-3

Developed by:
John C. del Regato
Mary E. Gilfeather
Jane A. Schwarm

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DEDICATION

Photo by Jimmy Mack

David

Kelly

Tom

April

The only ladder to the stars is woven with dreams. It is never easy to keep reaching for dreams. Strength and courage can sometimes be lonely friends — but those who reach walk in stardust.

—Flavia Weedn

ACKNOWLEDGMENTS

The authors would like to express their indebtedness to the thousands of students, parents, teachers, and administrators who since 1979 have shared their dream and helped them make it a reality. Each new center for the Mathematics Pentathlon® has attracted hundreds of dedicated educators as volunteers for this exciting Mathlete™ tournament.

For their dedication and for their leadership in directing past Mathematics Pentathlon centers the authors are indebted to: Carey Chappell, Emma Jean Couture, Jane Morton, Donna Nunn, John Peterson, and Stephanie Warren. The Pentathlon could not have succeeded these past years without their guidance and most generous assistance.

It is with great pleasure that we thank the many past directors of Division II for their warmhearted cooperation and assistance in refining the game rules for tournament competition. They also gave generously of their time to help orient thousands of volunteers to their responsibilities as tournament officials. We gratefully acknowledge John DiPiero, Karen Gifford, Penny Henderson, Jane Klonowski,Susan Knight, Susan Pardue, Diane Renihan, Tish Rudd, Nancy Schraeder, Janice Thompson, and Jeanne Zuchnik.

For their generous financial contributions to the development of the Pentathlon, we express our thanks to Lilly Endowment and Wickes Foundation. Without their assistance we would not have been able to develop the tournament as rapidly as we have.

From the thousands of volunteers who either gave of their time or personally supported the authors in making the tournament grow, we gratefully acknowledge the contributions of: Bea D'Ambrosia, Jeanne Angst, Darlene Atkins, Pam and Roger Barry, Sherry Bash, Ellen and Mark Bell, Dorothy Carver, Mary Chappell, Tom Clark, Richard Crowe, Diane del Regato, Juan and Inez del Regato, Betty and James Finkbeiner, Kathleen Fleming, Jo Ann Gentry, Nancy Goud, Sue Keene, Mark Keisling, Elaine Kemp, Paul Lindquist, Mike Metzger, Paula and Jim Minton, Vickie Moody, Robert O'Ana, Susan O'Brian, Hal Peterson, Mike Ropp, Heinz Schwarm, Wayne Taylor, Ben Wilson, and Mary Jo Wright.

Lastly, we congratulate the Mathletes who enthusiastically responded to the tournament and were placed in the Hall of Fame for their outstanding achievement.

March 15, 1986

John C. del Regato
Mary E. Gilfeather
Jane A. Schwarm

I wish to express my sincere appreciation to John del Regato and Mary Gilfeather for their excellent cooperation in preparing this manual. My sincere thanks also go to Marcia Kazmierzak, Sandra Barger, Debbie Webb, Victor Wampler, Chuck Lawson, Paula Fleetwood and Betty Landrum of the PDK staff for the preparation and printing of the materials. I owe a special debt of gratitude to Willard Duckett of the CEDR Center whose constructive suggestions have made my task that much easier. Finally, special thanks to Wilmer Bugher, my predecessor, for not only identifying this program but for his excellent assistance, guidance, and support at all times.

This manual is part of the eighteenth program offered by Phi Delta Kappa's Center for Dissemination of Innovative Programs since the Center was organized in 1972.

March 15, 1986

Neville L. Robertson, Director
Dissemination Center
Phi Delta Kappa

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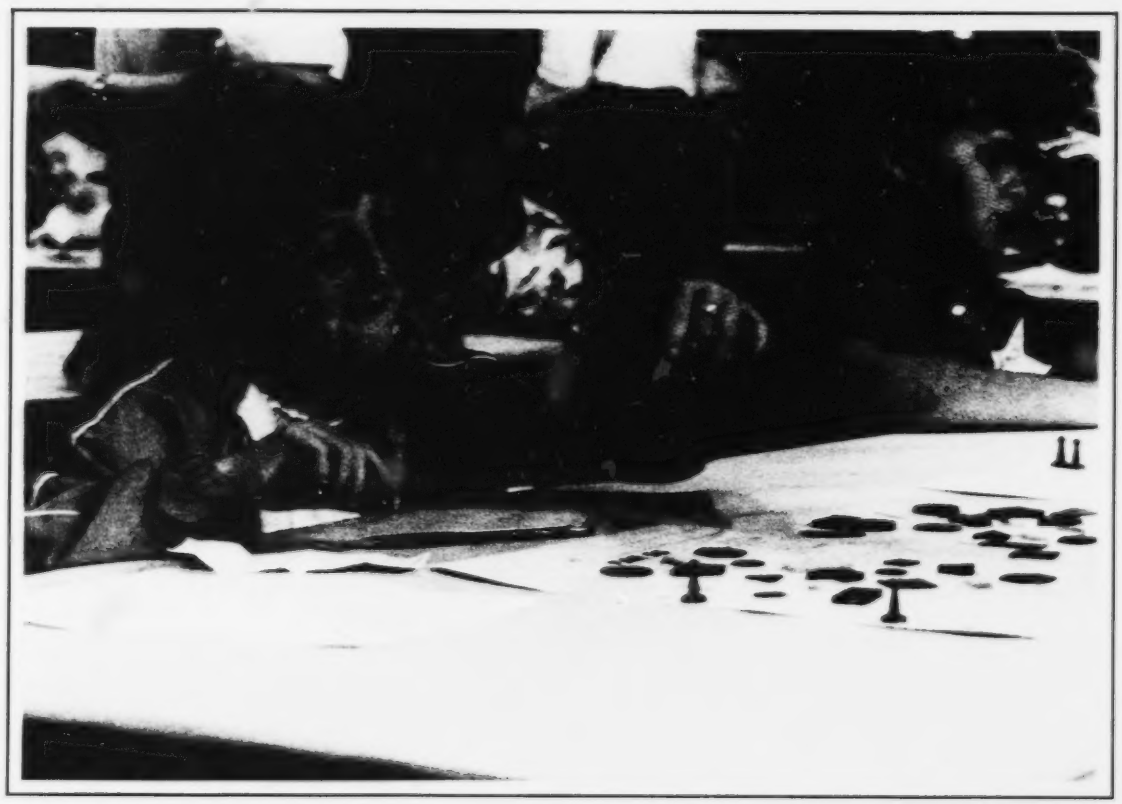

Photos by Eric Greulich

INTRODUCTION

The Mathematics Pentathlon® : Problem Solving in Action

The Mathematics Pentathlon brings parents, teachers, administrators, and learners together in an educational and social event which promotes the development of mathematical concepts and skills. This tournament of mathematics games held in spring appeals to a wide range of students at different ability levels and fosters interaction among all segments of the educational community. This event is referred to as a Pentathlon because there are 5 games in each of 4 divisions. Each division consists of two grade levels: Division I - grades K-1; Division II - grades 2-3; Division III - grades 4-5; and Division IV - grades 6-7. This event focuses on active problem solving and critical thinking skills. National assessments and international studies have shown that most children lack a true understanding of mathematics on a higher level which involves the development of critical thinking skills, logical and hypothetical reasoning, discerning patterns, and seeing new relationships. With this concern in mind, professional education organizations have often emphasized problem solving and reasoning skills. Continually mounting evidence suggests that the Pentathlon offers an excellent solution to this need.

The Pentathlon was organized as a tournament of mathematics games in 1979 as a tribute to the International Year of the Child. Since then it has become an annual event in the Tri-County area (Saginaw-Bay-Midland) of Michigan. This Center for the Mathematics Pentathlon is now under the leadership of parents and educators who believe it to be a most rewarding educational experience. In 1981 a new Tri-State Center (Indiana, Kentucky, Illinois) was established in Evansville, Indiana. Over the past years both of these centers have provided parents and educators with orientation sessions and in-service education programs related to the tournament. An ever-increasing volunteer support group of teachers, parents, administrators, and students has provided the best evaluative index of the impact this tournament has made.

In 1984 the Indianapolis center for the Mathematics Pentathlon was established. At the same time the National Headquarters for the Pentathlon was organized. Also located in Indianapolis, this headquarters is responsibile for assisting other centers and establishing new ones on a national basis. Since then a number of other centers for the Mathematics Pentathlon tournament have developed. It is estimated at this writing that well over 100,000 Mathletes™ nationally are involved in practicing these problem-solving games for tournament competition.

What has caused this dramatic involvement in a problem-solving tournament? Why is the Mathematics Pentathlon growing exponentially in the numbers of individuals involved? The answers to these questions appear to lie in the unique way this tournament has approached the crisis currently faced in mathematics education. Some of the unique features of the Mathematics Pentathlon are: 1) its focus on active problem solving; 2) its involvement of the total educational community; 3) its acceptance of a broad range of academic performance levels by participants; 4) its use of concrete and pictorial manipulatives; and 5) its balanced use of non-verbal and spatial reasoning.

Active Problem Solving

Alvin Toffler and other futurists have brought to our attention that our future is going to involve change at a rate even greater than present generations have experienced.

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This implies that future problems will involve a dynamic component which will be undergoing change even as those problems are being studied. It is clear then that a fundamental skill for dealing with the future is active problem solving, i.e., the ability to solve problems which are undergoing change during the process of attempts to resolve them.

The Mathematics Pentathlon® provides experiences in thought processes necessary for active problem solving. Through judicious use of logical analysis, spatial reasoning, computational reasoning, strategic thinking, and chance, the Pentathlon Mathlete™ attempts to resolve problems created by five entirely different two-person game events. Matched with a different opponent in each of the five tournament events, a Mathlete attempts to select a best option from a cluster of continually changing options. The Pentathlon game events rely to a great extent on the use of strategies. This provides experience in inductive and deductive reasoning through the use of systematic implementation of sequential thought. Such thought patterns are directly related to real life problem-solving situations. For example, the idea of networking is a combination of several different simultaneous approaches to the same problem.

Unlike other contests and competitions which provide individuals with static routine problems for solution by applying known algorithms, the Pentathlon focuses on non-routine types of problem-solving situations that foster the development of active problem-solving skills. But this emphasis on a dynamic approach to solving mathematical problems is not the only characteristic which makes the Pentathlon a unique experience.

Total Educational Community Involvement

The Pentathlon games were designed so that adults as well as children would enjoy them. Just as athletic programs are often supported by the home and school, the Pentathlon nurtures home and school involvement through supporting the efforts of each Mathlete who comes to a tournament. The great interest by both adult and student may be traced in part to the dynamic problem-solving features mentioned above. Parents, teachers, and administrators have found these games to be of educational value because they cover a variety of mathematical concepts and skills such as: basic arithmetic operations, fractions, decimal arithmetic and fraction/decimal conversion, classification and logic, and tranformational geometry to name a few.

Currently there are four divisions within this tournament with each division encompassing two grade levels: Division I - grades K-1, Division II - grades 2-3, Division III - grades 4-5, and Division IV - grades 6-7. A new Division V for grades 8 and 9 is presently being constructed. Within each division there are five different games which reflect the mathematical concepts and skills appropriate for that grade level.

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During the months of August through December, parents and educators are oriented to the games that comprise the tournament. These individuals then teach their children the games at home and/or in school and prepare and select those Mathletes™ who will register for tournament competition. These same individuals also decide whether or not they will volunteer their services as one of the Pentathlon tournament officials or as one of the many volunteer assistants. Another unique feature of the Mathematics Pentathlon® is the ratio of Mathletes™ to tournament volunteers — 2:1! This type of volunteer support is only possible because of the pride and ownership that parents and educators feel toward this event.

Representatives From a Broad Range of Academic Performance

Currently the Pentathlon consists of a total of 20 different games. Each of these games is either an original creation or some significant modification of a known game. Considerable care has been taken in designing the five different two-person games for each division. Factors which entered into the development process included: 1) creating games sensitive to the developmental differences of students; 2) providing well defined rules and instructions for tournament play; 3) designing games which support and supplement formal mathematics curricula; 4) making the games appealing to both students and adults by blending both strategy and chance within the games; and 5) emphasizing the variety of ways manipulation of physical models can be used in problem solving. The first criterion in this list has enabled the Pentathlon to attract students from a broad range of academic performance. Since the games employ non-verbal as well as the more traditional symbolic and computational aspects, many students who are strong in non-verbal or spatial reasoning abilities are attracted to the Pentathlon games which require this type of thinking. Often a child may be very skilled in this type of reasoning and yet be either disinterested and/or poorly skilled in the verbal and quantitative skills so valued within formal instructional settings. Many such students have found the Pentathlon experience to be rewarding not only because it values spatial reasoning and non-verbal ability, but because it provides a vehicle for motivating the development of logical and quantitative thinking. The child of average academic performance may also be similarly motivated. And, the student who excels academically is also challenged by the games which require multiple classification and/or geometric and spatial reasoning. The active problem-solving feature discussed above fascinates all. But, the creative use of physical models to represent the underlying mathematical concepts is yet another reason why the Pentathlon has such a broad range of appeal.

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Physical Models

The tournament games employ a variety of educational manipulatives. Examples of such materials are pattern and attribute blocks, Cuisenaire rods, pentominoes, dominoes, and fraction bars. Although research studies have indicated the great value these and other physical models have for developing children's mathematical thinking, children often have little or no experience with these valuable learning tools.

Problem solving most typically requires the solver to build a model or create a picture of the problem. Many students have not been provided with experiences which make use of physical or pictorial models in the development of mathematical ideas. Typically these students lack the necessary imaging for resolving mathematical problems that have a spatial reasoning component. Since all of the mathematical ideas studied in grades K through 12 can be communicated using visual models, it appears most reasonable to enrich a child's experience by the appropriate use of concrete and pictorial instructional manipulatives.

Parents and educators are often surprised by the way in which physical models enable a child to investigate mathematical relationships that were not easily seen with the use of symbols alone. Parents appreciate the value of these objects as they see their child conquer the strategies used in a Pentathlon game. These parents then become most supportive of the need and use of these materials in their child's ongoing formal instruction. Teachers and administrators also gain a renewed respect for the way in which physical and pictorial models enrich the imaging related to mathematics concept development.

The Future

It is through the efforts of many dedicated parents and teachers that the Mathematics Pentathlon® has become an established annual event. All indicators point to a bright future for this unique tournament. If you would like to see a Pentathlon, attend one of the many planned orientation sessions, or arrange your own inservice workshop, call (317) 926-MATH for further information. There is no doubt that the Pentathlon's focus on active problem solving is providing an avenue for children to experience tomorrow's mathematical skills. We can no longer look to the future through a rearview mirror. Rather than a nostalgic return to the past emphasis on the basics of arithmetic memorization and drill, the Pentathlon stresses fundamentals that are future oriented. By acquiring active problem-solving skills, Mathletes™ can look to future challenges with confidence.

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FIAR

(Four In A Row)

Created by
Dr. John C. del Regato

The ability to recognize different structural relationships is developed in this Mathematics Pentathlon® event. It is an alignment game in which two players take turns placing their markers in any open circle on the gameboard. After placing all markers onto the gameboard they are moved along a straight path to form a line of markers of the same color. Getting four markers in a line, with no opponent's marker intervening, wins. Similar to the more traditional games of Three-Dimensional Tic-Tac-Toe and Crystals in attempting to place objects in a specified structured relationship, this event allows for an additional dynamic element of moving markers to enhance the use of various strategies. There are millions of possible playing sequences which await each Mathlete™ in this challenging linear visualization game.

UNDERLYING MATHEMATICS/SCIENCE: horizontal, vertical, and diagonal placement and movement, identifying structural compositions necessary for constructing a linear path, spatial reasoning; observation skills, hypothesizing and experimentation, deductive and inductive reasoning

MATERIALS: Official Mathematics Pentathlon® gameboard, seven (7) markers of one color and seven (7) markers of a different color

TIME: Total tournament playing time is thirty (30) minutes. Each player has one minute to complete a turn. When a player is first learning the game, more time should be allowed.

GOAL: To win, a player must be the first to get four (or more) markers of the same color (not necessarily the player's color) in a straight connected line with no marker(s) of the opposite color intervening.

TO START:

A. Designate one of the two colors as the beginning player's color. Place all markers into a container and have a player select without looking at one of the markers. If the marker is the color designated for beginning the game, the player begins. If not, the opposing player goes first.

B. The beginning player takes all seven (7) markers of the same color. The opposing player takes all seven (7) markers of the opposite color.

RULES:

1. **Alternating Turns:** Players alternate taking turns.

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2. **Phase I — Placement:** During a turn each player places a marker onto one of the unoccupied circles. This is continued until each player has placed all seven (7) markers onto the gameboard. If four or more markers are placed in a straight connected line with no marker of the opposite color intervening a win can be claimed during this placement.

3. **Phase II — Movement:** After each player has placed all seven markers on the gameboard, markers may be moved in a straight connected line along the lines joining the circles. Markers may be moved any number of spaces desired along a straight path but may not jump over an opponent's marker nor occupy the same circle with another marker.

4. **Touch-Move:** Once a marker has been touched it must be moved by the player during that turn.

5. **Beginning a Turn:** A player's turn begins when the opposing player has placed a marker or moved a marker into position for that turn and has released hold from the marker.

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6. **End of Turn:** A player's turn ends when a marker is placed or moved into the final position for that turn and the player's hand is released from the marker.

7. **Winning on Player's Markers:** When a player has placed or moved markers so that four of the player's markers are on a straight connected path without an opponent's marker intervening, a win can be declared. This must be done by announcing "**F**our **I**n **A R**ow" before releasing hold of the marker placed or moved during that turn. Should a player fail to identify a winning path, the opposing player may do so (see Rule 8). The four markers constructing the winning path need not be consecutively spaced. There may be unoccupied spaces between the four markers. There may also be other markers in the winning row as long as they are not intervening with the "Four in a Row."

8. **Winning on Opponent's Markers:** A player may move a marker in such a way that it results in a straight connected line of four of the opponent's markers. The player can claim (see Rule 7) this situation as a winning path even though the markers constructing the path belong to the opponent. The four markers constructing the winning path need not be consecutively spaced. Also, if an opponent does not claim a winning path, a player can move any marker and claim the winning path before releasing touch from the marker.

TOURNAMENT RULES:

9. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge at the end of the player's turn and before touching a marker. To indicate that a challenge is being made a player must announce "challenge." A Mathematics Pentathlon® official must rule on this challenge. In order to do so, an official time out will be granted and the official will ask the challenger to state the nature of the challenge. The official must rule on whether the challenge as stated by the player is correct or incorrect. If the challenge is found to be correct, the gameboard will be restored to where the markers were positioned at the beginning of the challenged player's turn and the challenger will begin a turn. If the challenge is found to be incorrect, the challenger will forfeit a turn.

10. **One Minute Time Limit:** Each player must complete a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon® official will restore the gameboard to where all markers were

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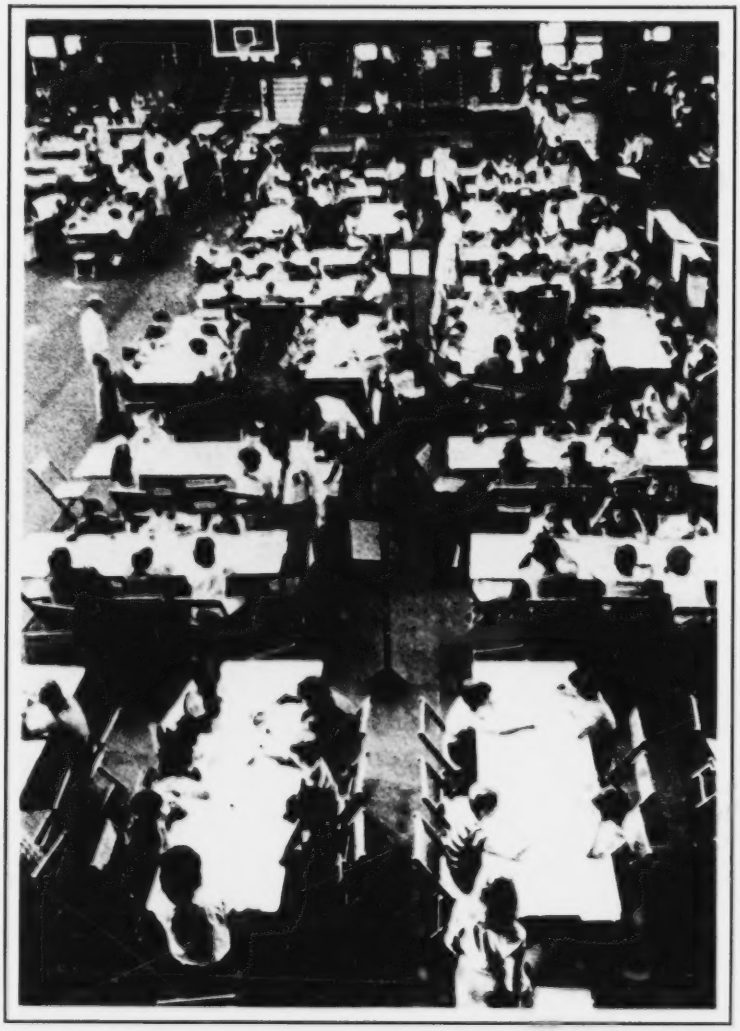
positioned at the beginning of that turn and the player forfeits that turn. The third violation of this rule results in a forfeiture of the game. Players may not challenge each other over this rule at the Mathematics Pentathlon® . An official at the tournament will decide whether or not this rule is being violated.

11. **Game Time Limit:** At the Mathematics Pentathlon® , if the thirty (30) minutes of game time has run out before either player has declared a win, a tie is declared. If a player has touched a marker and is in the process of moving it when game time is called, the player will be allowed to complete that turn. If game time is called and a player has not touched a marker for movement, the game has ended and a tie is declared.



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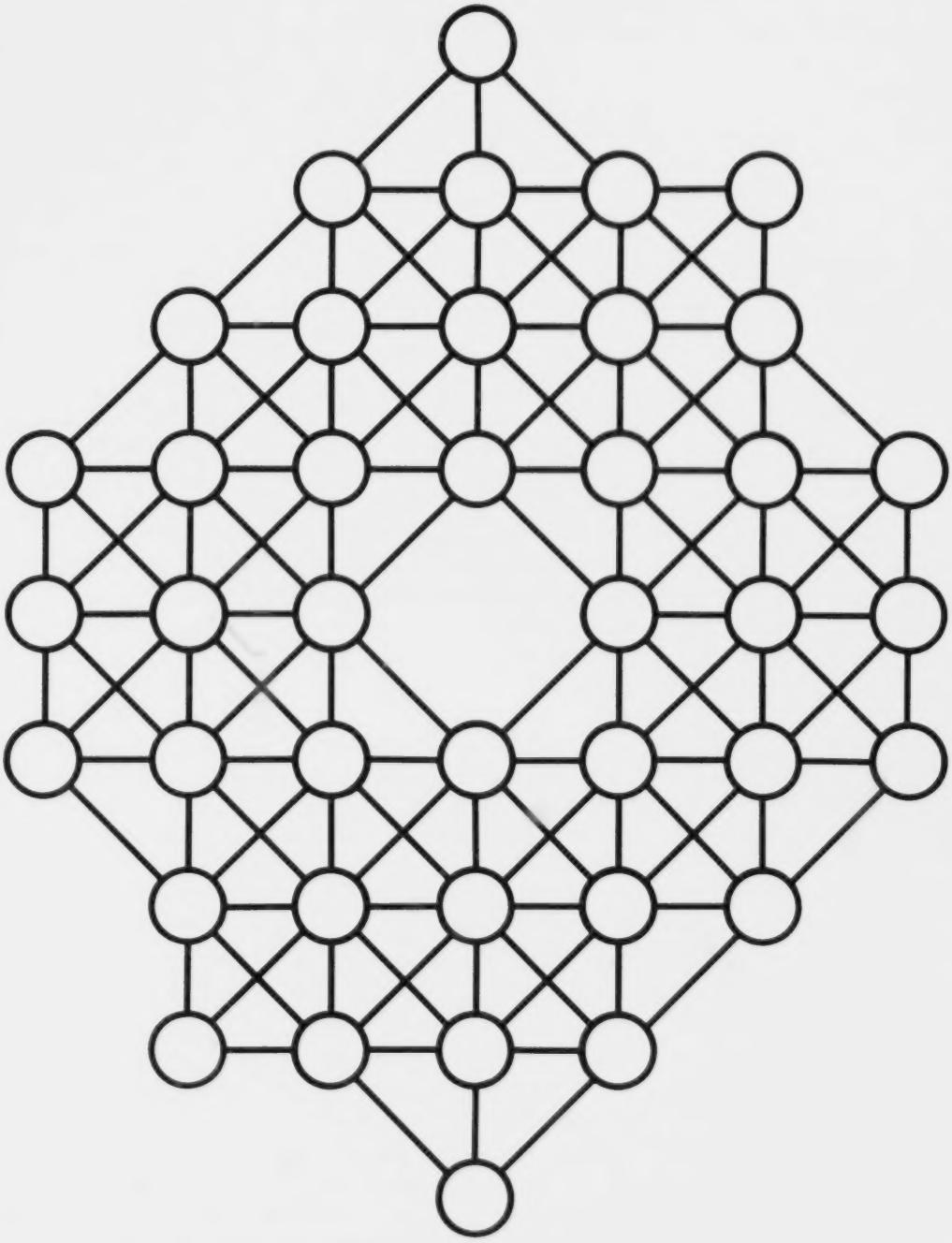
FIAR



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SUM DOMINOES & DICE

Created by
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Several types of domino games are played in countries all over the world. The dot configuration used in dominoes is thought to have originated in China and to have been brought to Europe in the fourteenth century. We know that in the eighteenth century domino games were played in Italy and in recent times they have been popular in certain Latin American countries.

This Mathematics Pentathlon® event combines the use of dice and dominoes in a game which provides practice in basic addition facts and in the missing addend form of subtraction. Experience with domino games and standard configurations of quantities zero through nine is helpful but not a necessary prerequisite for success in this event. It is strongly recommended, however, that those Mathletes™ who have not experienced dominoes, work through the illustrations associated with the rules using a set of double-nine dominoes.

UNDERLYING MATHEMATICS/SCIENCE: counting, number recognition, addition, missing addend form of subtraction, greater than-less than, combinatorics; observation skills, deductive and inductive reasoning

MATERIALS: Official Mathematics Pentathlon® gameboard, a set of double-nine dominoes, three regular dice

TIME: Total tournament playing time is 30 minutes. Each player has one minute to complete a turn. When first learning this game, the time limit should be longer.

GOAL: To win, a player must be the first to get rid of all dominoes. If this does not occur the player with the fewest number of spots is the winner. If both players succeed in using up all of their dominoes at the end of a round, a tie is declared. A tie is also granted if both players end the game with the same number of spots.

TO START:

A. All dominoes are turned face down and thoroughly mixed. These dominoes form a bank or draw pile.

B. Each player alternates in drawing seven dominoes from the bank and places them face up so that they can be seen by both players. These dominoes form each player's playing pieces or what is known as a hand.

C. Each player takes a turn at rolling all three dice. The player with the lowest sum begins play.

D. The beginning player selects another domino from the bank and places it face up onto the designated center space on the gameboard (the playing area).

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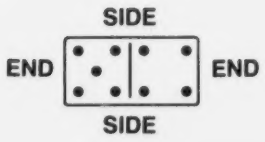
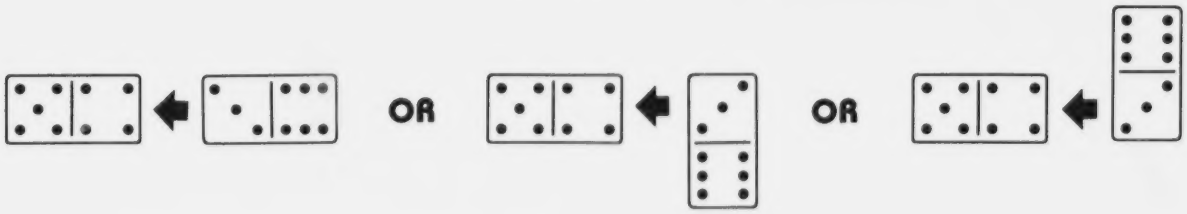
RULES:



1. **Beginning Player's First Turn:** In addition to placing a domino onto the gameboard, the beginning player rolls all three dice and determines the sum of all dots on the top faces of the dice. From the seven dominoes which constitute the player's hand, the beginning player selects one which can be placed onto one of the ends of the domino on the gameboard. It must be placed so that one face of a domino on the gameboard and one face of the domino placed onto the gameboard add up to the total amount showing on all three dice. The *end* or *side* of the domino placed onto the board must be placed next to the *end* of the domino on the gameboard (see Rule 3). For example, if a total of seven is rolled, the beginning player could do one of the following:



After placing a domino onto the gameboard so that these conditions are satisfied or after determining that a domino cannot be placed onto the gameboard under these conditions, one domino is selected from the bank and placed face up among the player's hand.

2. **Alternating Turns:** Players alternate taking turns. With the exception of the beginning player's first turn described in rule 1, **each player's turn consists of two parts:**
   a) reacting to the opponent's roll of the dice and trying to select an appropriate domino to place onto the gameboard; and
   b) proceeding with one's own roll of the dice and again attempting to place an appropriate domino onto the gameboard.

   After a player has completed a roll of the dice and attempted to place an appropriate domino onto the gameboard, a domino must be drawn from the bank and placed face up onto the player's hand. This is done regardless of the player's success at placing a domino onto the gameboard.

3. **End-to-End and End-to-Side Placement:** All dominoes (with the exception of doubles, see Rule 4) must be placed onto the gameboard in an end-to-end or end-to-side fashion. This means that the *end* of a domino on

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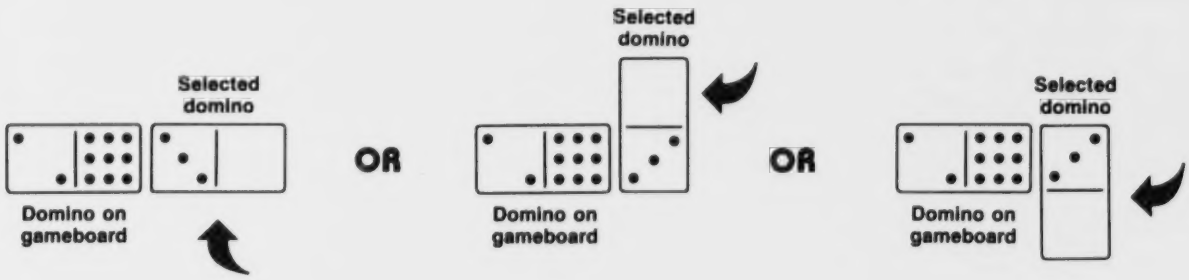
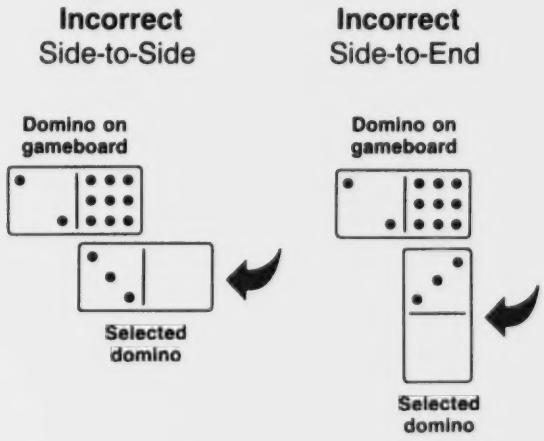
the gameboard must be used to contact the end or side of the appropriate face of a domino placed onto the gameboard. For example, if the dice sum is twelve, a player may place a domino onto the gameboard in one of the following ways:

CORRECT PLACEMENT:



INCORRECT PLACEMENT: Side-to-End and side-to-side placement is not permissible. The side of a face of a domino on the gameboard may not be used to contact the side or end of a piece placed onto the playing area.



4. **Placement of Doubles:** Dominoes with the same number of dots on both faces are called doubles. All doubles must be placed on an end-to-side basis i.e., the end of a domino on the gameboard must contact the side (middle) of the double placed onto the playing area. For example, if the dice sum is seven and a double is placed

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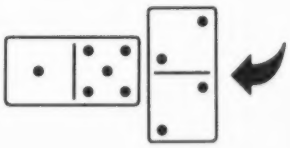
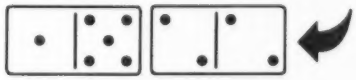
onto the gameboard, it would look like this:

CORRECT PLACEMENT:



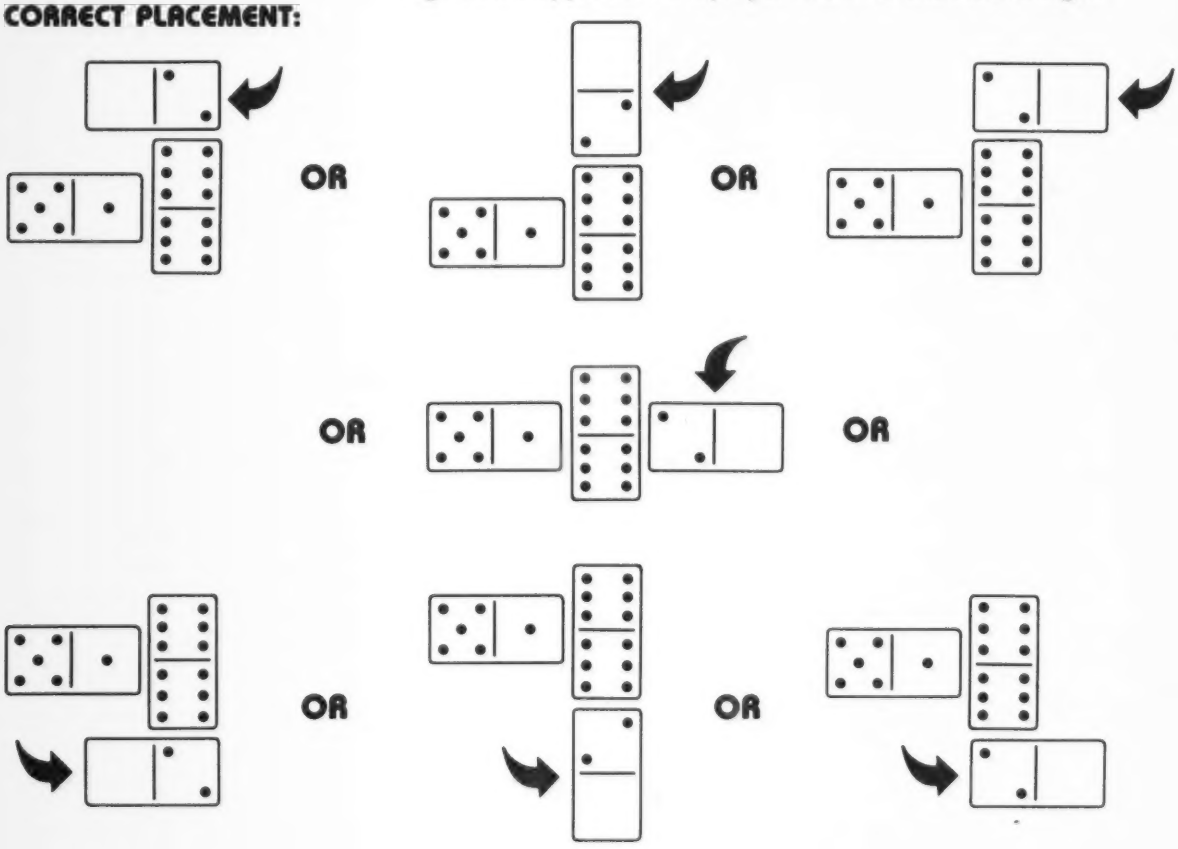
The end of a double placed onto the gameboard may not be used in placement. The double discussed in the above example, *may not* be placed in the following manner:

INCORRECT PLACEMENT:



5. **Playing off of Doubles:** Doubles which have already been placed onto the gameboard can have their sides or ends used for placing other dominoes onto the playing area. Suppose that a player's sum of the dice is eight:

CORRECT PLACEMENT:



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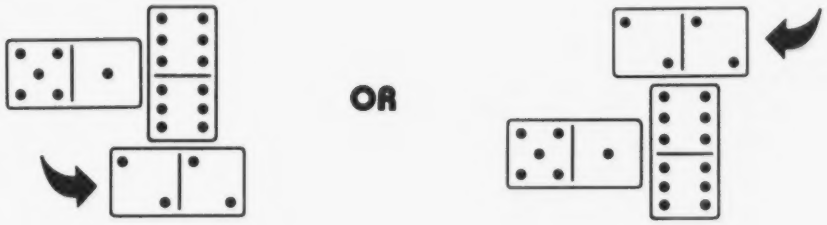
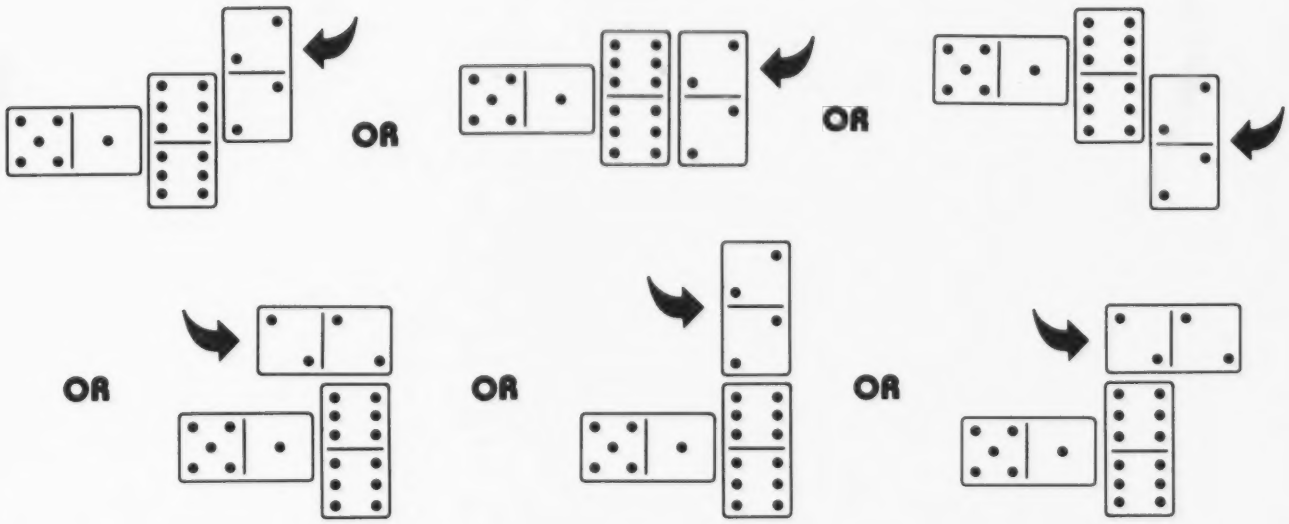
If a double were to be placed onto a double already on the gameboard, the following illustrate a correct placement for a sum of eight.



INCORRECT PLACEMENT: Using the same example for the sum of eight the following illustrate an *incorrect* placement:

A player placing a double onto a double incorrectly:



or the mirror images of the last three illustrations.

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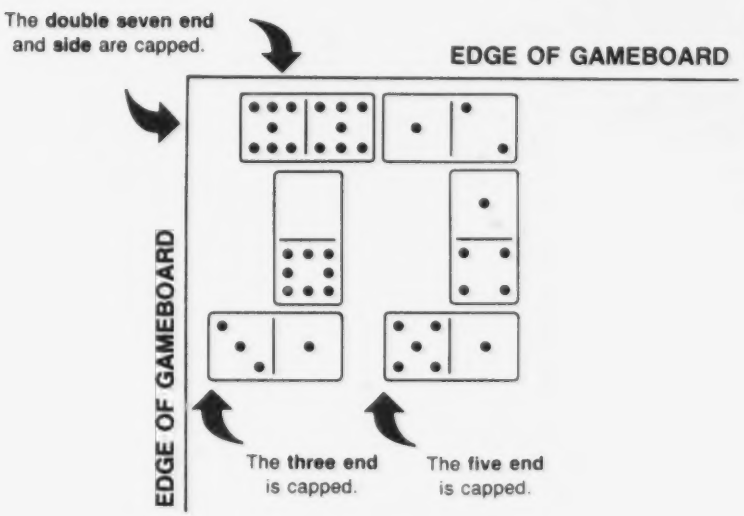
6. **Selected Dominoes Must Be Played:** Once a selected domino has touched the gameboard it must be used to complete that part of a player's turn. If a player discovers (or is challenged see Rules 14, 15, and 16) that the selected domino cannot be used to complete the designated sum, the domino is returned to the player's hand and a domino is drawn from the bank. The player must forfeit that part of the turn. If such a misplacement occurs during the first part of a player's turn (see Rule 2), that part and the second part of the player's turn are forfeited.

7. **Placed Dominoes May Not Be Repositioned:** Once a player has placed a domino onto the gameboard and it has been released from a player's touch it *may not* be repositioned.

8. **Don't Bank On It:** The domino drawn by a player at the end of a turn may not be used during that turn. If a player was unable to place a domino onto the gameboard, the selected domino drawn from the bank *may not* be used even if it does provide the desired sum.

9. **Capping a Domino:** If the physical arrangement of the dominoes on the gameboard does not allow an additional domino to be added without touching other dominoes or going over the edge of the gameboard, the exposed ends (or side of a double) are said to be capped and can no longer be used for the placement of other dominoes. For example, in the illustration below, the five end of the lower right hand domino has been capped.


The double seven end and side are capped.
EDGE OF GAMEBOARD
EDGE OF GAMEBOARD
The three end is capped.
The five end is capped.

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10. **Beginning of a Turn:** A player's turn begins when the opposing player has released hold of the selected domino drawn from the bank. When there are no more dominoes in the bank, a player's turn begins when the opposing player has released hold of the domino placed onto the gameboard during the second part of the opponent's turn. When the bank is empty and the opposing player cannot find a domino to place for the second part of a turn, a player's turn begins when the opponent says "pass."

11. **End of a Turn:** A player's turn ends when a domino drawn from the bank is placed among the other playing pieces. If the bank is empty, a player's turn ends by announcing "pass" or by releasing hold of a domino onto the gameboard during the second part of a turn.

12. **End of the Game:** The game has ended when:
    a) a player has placed the last domino of a hand onto the gameboard during the first part of a turn,
    b) the bank has been depleted and a player has placed the last domino of a hand onto the gameboard during the second part of a turn,

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c) all exposed ends or sides (for doubles) of dominoes on the gameboard have been capped,
d) or the bank has been depleted and, both players have completed a turn with neither player adding a domino to the playing area.

13. **Win/Tie:** A player who, within the first part of a turn places the last domino from a hand onto the gameboard is the winner. If there are no dominoes in the bank, a player can win by placing the last domino from a hand onto the gameboard during the second part of a turn. If during the second part of a turn there are dominoes remaining in the bank and a player places the last domino from a hand onto the gameboard, a domino must be drawn from the bank and play continues. This *does not* constitute a win. If the game has ended and both players have dominoes remaining in their hands, the winner is the player with the least number of dots on all domino faces. If both players have the same number of dots, a tie is declared.

TOURNAMENT RULES:

14. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge. To indicate that a challenge is being made a player must announce "challenge". A Mathematics Pentathlon® official must rule on this challenge. In order to do so an official time out will be granted and the official will ask the challenger to state the nature of the challenge. The official must rule on whether the challenge as stated by the player is correct or incorrect. Either part of a player's turn may be challenged. If correct the challenger would then begin a turn.

15. **Challenges to the First Part of a Turn:** A challenge to the first part of a player's turn must be announced before a player touches the dice to complete the second part. It must be announced immediately after a domino is released onto the gameboard. If a challenge to the first part of a turn is found to be correct, any inappropriately placed domino must be returned to the challenged player's hand. And, the challenged player must select another domino from the bank (see Rule 6). If the bank is empty, a domino is selected from the challenger's hand by the challenger and is added to the dominoes in the challenged player's hand. The challenged player must forfeit the second part of a turn. Should the challenge be found to be incorrect, the challenged player will be granted an additional toss of the dice after completing the second part of a turn.

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16. **Challenges to the Second Part of a Turn:** A challenge to the second part of an opponent's turn must be announced at the beginning of a player's turn before the dice have been picked up. If a challenge to the second part of a turn is found to be correct, the challenged player would return the inappropriate domino to his or her hand and draw an additional domino from the bank. An incorrect challenge to the second part of a player's turn results in the challenger forfeiting a complete turn. The challenged player would be granted two additional tosses of the dice.
17. **Challenges to the Second Part of a Turn for the Nonplacement of a Domino:** If a player does not place a domino during the second part of a turn but an appropriate domino could have been placed, that player may be challenged. In this situation the opponent must announce the challenge after the player has drawn a domino from the bank. The challenger would then describe an appropriate domino placement. If the challenger is correct, the challenged player would draw an additional domino from the bank. If the challenger is incorrect, the challenged player would be granted an additional toss of the dice.
18. **One Minute Time Limit:** Each player must complete both parts of a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon® official will have the player select a domino from either the bank or the opponent's hand (if the bank is empty). The third violation of this rule results in an automatic forfeiture of the game. Players may not challenge each other over this rule at the Pentathlon. An official at the tournament will decide whether or not this rule is being violated.

19. **Game Time Limit:** At the Mathematics Pentathlon® , if the thirty (30) minutes of game time has run out before either player has ended the game, a win or tie will be declared based on the number of dots appearing on each player's dominoes (see Rule 13). If a player is in the process of completing a turn but has not completed both parts to a turn when game time is called, that turn will be allowed to be completed.

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GAMEPIECES FOR SUM DOMINOES & DICE

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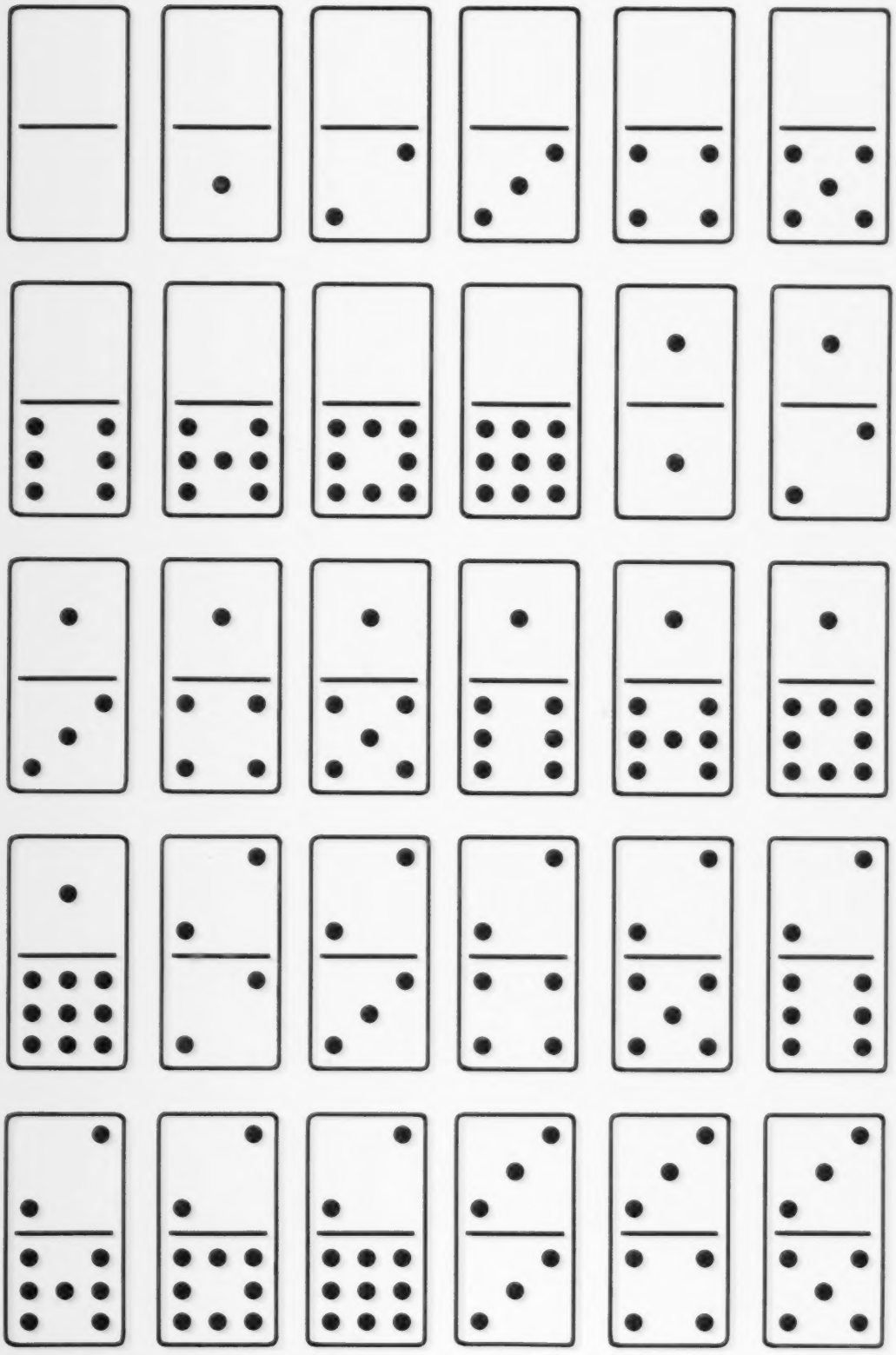

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GAMEPIECES FOR SUM DOMINOES & DICE

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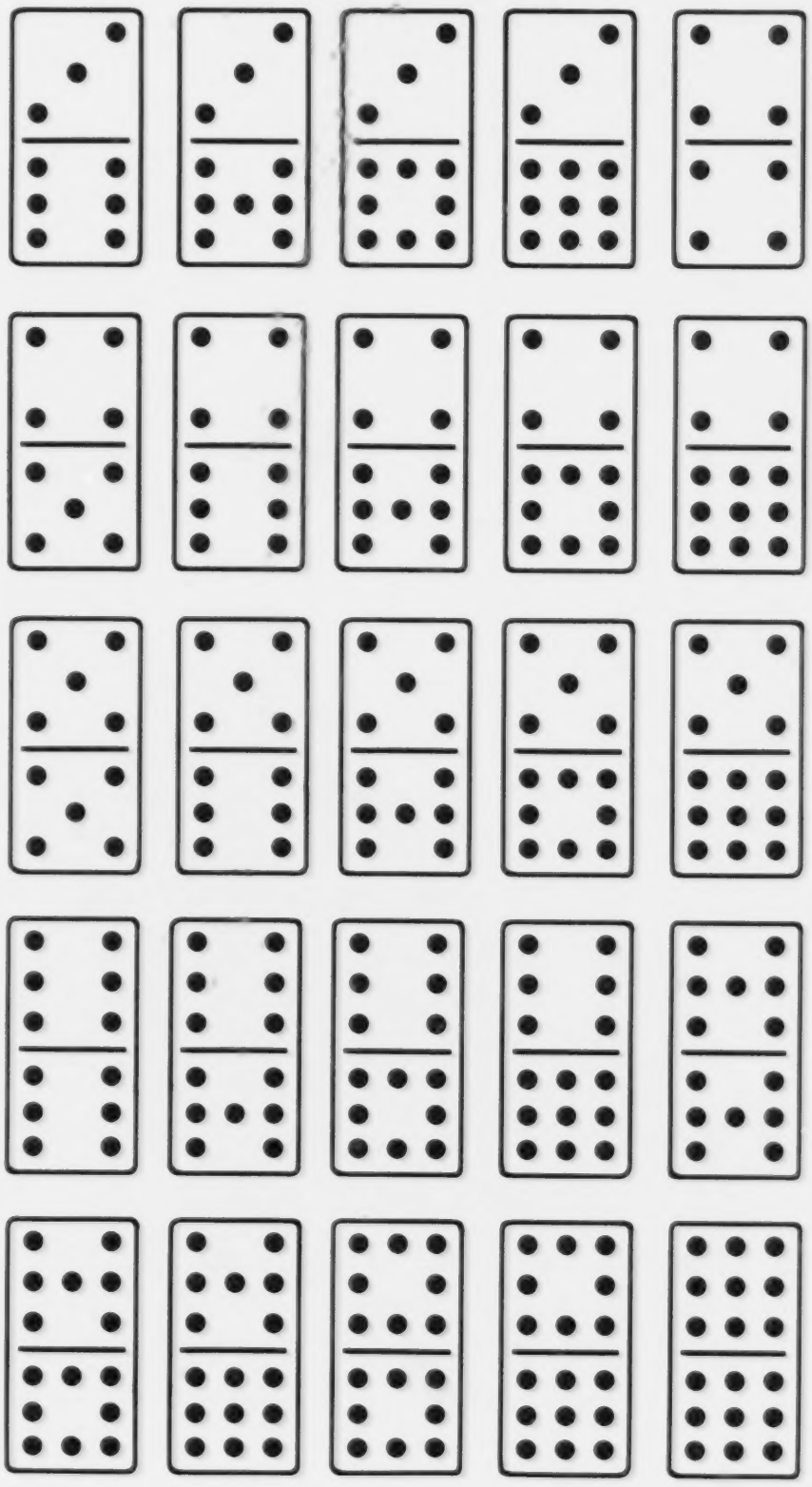

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This page can be used to make an overhead transparency.

SUM DOMINOES & DICE

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RAMROD

Created by
Dr. John C. del Regato

This strategy mathematics game calls for the ability to plan ahead and appropriately sequence moves so that two rods (or colored strips) are combined to fill up a rectangular box within the framed area of the gameboard. Although a working knowledge of addition and missing addend form of subtraction is most helpful in succeeding at this Mathematics Pentathlon® event, certain strategies in sequencing moves can be developed to improve a player's technique. Before introducing this game to potential Mathletes™, some time should be taken to investigate the relationship between the rods of various lengths. The different possible combinations of two rods which can completely fill each of the rectangular boxes within the framed area of the gameboard should be explored. The rods used in this game have metric lengths so that metric measurement is informally experienced. The rods range from one centimeter to ten centimeters or a decimeter in length.

UNDERLYING MATHEMATICS/SCIENCE: addition, subtraction (missing addend), greater than-less than, equality, metric measurement, estimation; observation skills, experimentation, deductive and inductive reasoning

MATERIALS: Official Mathematics Pentathlon® gameboard, Cuisenaire® Rods*

TIME: Total tournament playing time is thirty (30) minutes. Each player has one minute to complete a turn. Prior to the tournament when first learning the game, more time should be granted.

GOAL: To win, a player must capture sufficient rods off the framed playing area to construct a ramrod equal or greater in length to the long narrow box along the player's edge of the gameboard (25 cm).

TO START:

A. Two rods of differing length are selected and hidden from view. One rod is placed in the right hand and the other in the left hand. A player chooses the right or left hand. The player with the longer rod is designated the beginning player.

B. All rods are placed onto the starting position boxes of corresponding length. Only the starting boxes outside the framed playing area are to be filled. All boxes inside the framed playing area are not to contain any rods at the start of the game. Also the ramrod boxes (25 cen-

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timeter box) at each end of the gameboard are to be empty at the start of a game.

RULES:

1. **Taking a Turn:** Players alternate taking turns. During a turn, a player may slide a rod from a starting position box on the player's side of the gameboard into a box within the framed playing area. Also, **with the exception of the last rod moved by the opposing player**, a player can move one of the rods in the framed playing area from one box to another box within the framed playing area. Still another option for a player to complete a turn is to pick a rod out of the large central rectangular box and to reposition it onto a starting box of equal or greater size than that of the selected rod. No more than one rod can be moved during a turn.
2. **Rod Movement:** Rods are moved from one box to another along the connecting lined paths shown on the gameboard. They are only moved from one box to the next connected box on any given path. The rods can be moved in any direction along the lined paths within the framed playing area of the gameboard, but are not to

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be moved from any of the narrow rectangular boxes in the framed area back to a starting box. Any rod within the central framed playing area can be moved by either player with the exception of moving the last rod moved by the opponent (see Rule 4).

3. **Sufficient Room:** A rod may be moved into a box provided there is sufficient room for it. More than two rods may occupy a box under this rule as long as their combined lengths do not exceed the length of the box.

4. **Rods Not To Be Moved:** A player may not move rods out of or into the opposing player's starting boxes. Also, **a player may not move the last rod moved by the opposing player**.

5. **Capture:** When a player has succeeded in filling a narrow rectangular box within the framed playing area with exactly two (2) rods, the rods are removed from the playing area and placed end-to-end onto the long narrow rectangular ramrod box at the player's edge of the gameboard.

6. **Large Central Rectangular Box:** Any rod can be moved into or out of the large central rectangular box by using the connecting paths designated on the gameboard. No captures as described in Rule 5 are made within this space. Rods contained within this space may be repositioned to one of a player's start boxes.

7. **Repositioning or Recycling:** A rod within the large central rectangular box at the center of the gameboard may be recycled back to one of a player's start boxes. A recycled rod must be repositioned onto a starting box of the same size or larger than the rod. When a player exercises this option during a turn, a starting box which is of the same size or larger than the repositioned rod must be available. If no such box is available this option cannot be exercised. More than one rod can be repositioned into the same starting box provided Rule 3 is not violated.

8. **Beginning a Turn:** A player's turn begins when an opponent has moved a rod into a different box and is no longer touching the rod or, in case of capture, when an opponent is no longer touching the rods placed into the ramrod box.

9. **End of Turn:** A player's turn ends when the player's hand is removed from a rod which has been moved into a different box. In the case of a capture, the turn ends when a player is no longer touching the rods placed into the

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ramrod box. Note that Rules 8 and 9 allow a player to realign rods within a box without penalty. A player may also move a rod to a different box but while still holding or touching the rod decide to place that rod back where it was and move a different rod.

10. **A Round:** A round consists of the beginning player and second player completing a turn.

11. **Win/Tie:** At the end of a round, the player who has constructed a ramrod (with rods captured off the playing area) as long as or longer than the ramrod box (25 cm) is the winner. If both players construct a ramrod of 25 cm or more at the end of a round, the player with the longer ramrod wins. If the ramrods of 25 cm or more are both the same length at the end of a round, a tie is declared.

TOURNAMENT RULES:

12. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge after a player's hand has been removed from a rod and thus ending a turn. To indicate that a challenge is being made a player must announce "challenge." A Mathematics Pentathlon® official must rule on this challenge. In order to do so an official time out will be granted and the official will ask the challenger to state the nature of the challenge. The official must rule on whether the challenge as stated by the player is correct or incorrect. If the challenge is found to be correct, the gameboard will be restored to where the rods were positioned at the beginning of the challenged player's turn and the challenger will begin a turn. If the challenge is found to be incorrect, the challenger will forfeit a turn.

13. **One Minute Time Limit:** Each player must complete a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon® official will restore the gameboard to where all rods were positioned at the beginning of that turn and the player forfeits that turn. The third violation of this rule results in a forfeiture of the game. Players may not challenge each other over this rule at the Mathematics Pentathlon® . An official at the tournament will decide if this rule is being violated.

14. **Game Time Limit:** At the Mathematics Pentathlon® , if the thirty (30) minutes of game time has run out before either player has ended the game, a tie is declared. If a player has touched a rod and is in the process of moving it when game time is called, the player will be allowed

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to complete that turn. Should any rods be captured in the process so that a ramrod of 25 cm or longer is constructed, a completion of a round will be granted. Should both players have ramrods of less than 25 cm when game time is called, a tie will be declared. If game time is called and a player has not yet touched a rod for movement, the game has ended.

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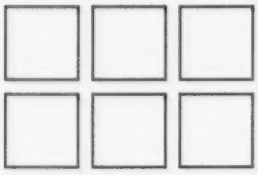
GAMEPIECES FOR RAMROD

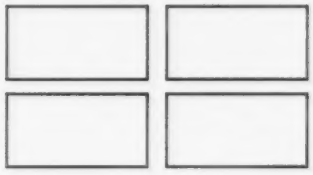
DUPLICATE THIS PAGE

Please color the strips as indicated.

WHITE

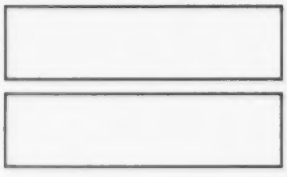


RED

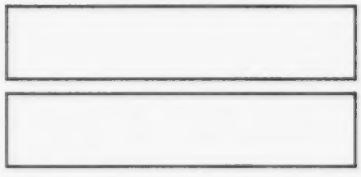


LIGHT GREEN

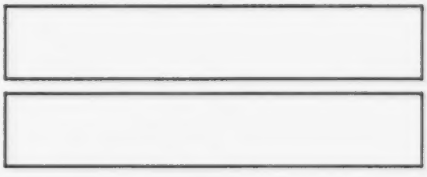
PURPLE



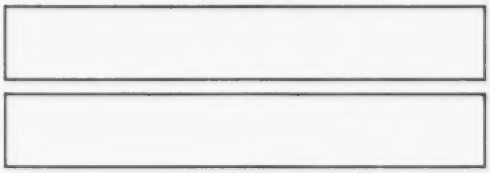
YELLOW



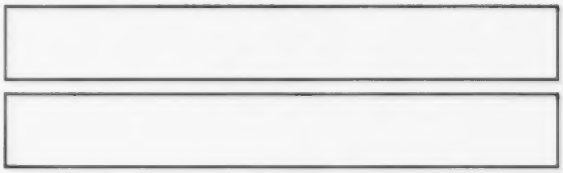
DARK GREEN



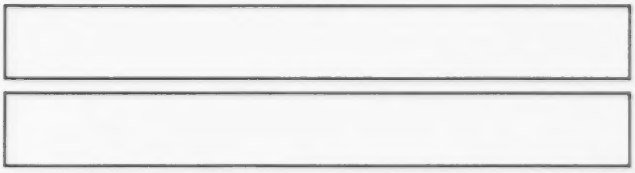
BLACK



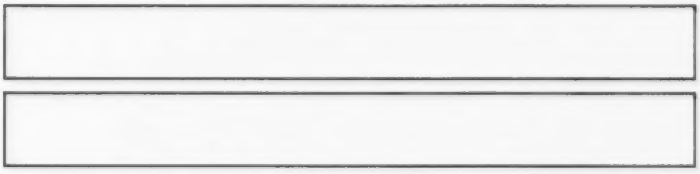
BROWN



BLUE



ORANGE



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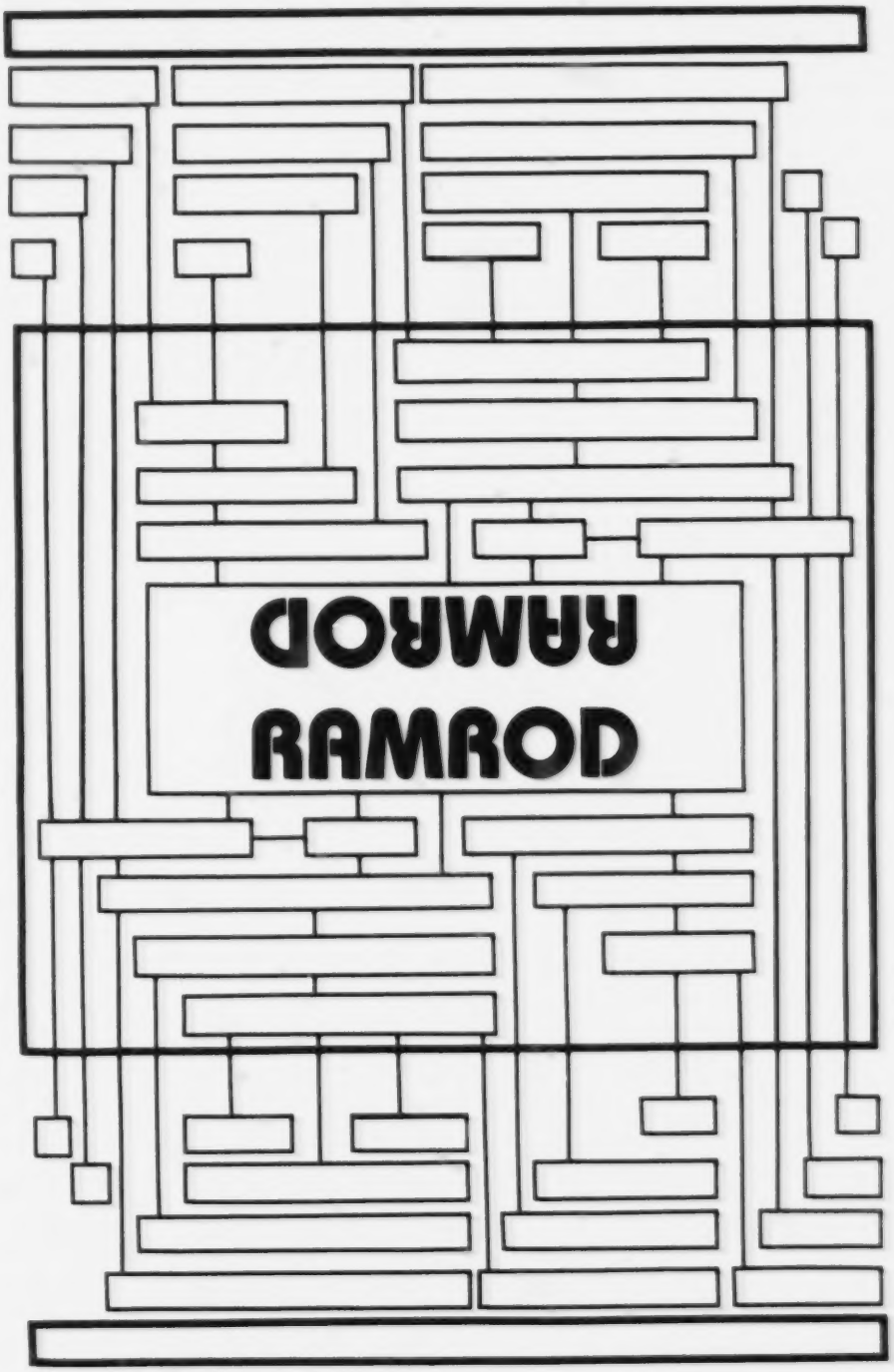

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PAR 55

(Perception Attribute Race)

Created by
Dr. John C. del Regato

This Mathematics Pentathlon® event is a **P**erception **A**ttribute **R**ace (PAR) game, the goal of which is to be the first player to land on step 55. It gives practice in differentiating and sorting information. Geometric attribute pieces are placed on a specially designed gameboard in an attempt to maximize a playing score, bump an opponent's marker back five spaces, or land a marker on a safe numbered space. The multiple classification skills developed in this game help a Mathlete™ learn how to deal with problems involving more than one variable.

UNDERLYING MATHEMATICS/SCIENCE: shape recognition, multiple classification, structural relationships of attributes, counting and addition; observation skills, hypothesizing and experimentation, deductive and inductive reasoning

MATERIALS: Official Mathematics Pentathlon® gameboard, sixty (60) piece geometric attribute block set, two (2) scoring markers — of different color, paper and pencil (optional)

TIME: Total tournament playing time is thirty (30) minutes. Each player has one minute to complete a turn. Prior to tournament competition when first learning the game, more time should be allowed.

GOAL: To win, a player must reach space 55 without the opposing player succeeding in doing the same on the following turn.

TO START:

A. One of the marker's colors is selected as the starting color. The two scoring markers are placed into a container. Without looking, a player draws out one of the markers. The remaining marker belongs to the opposing player. The player having the starting color begins play.

B. Both players place their scoring markers on the gameboard in the space labeled START.

C. The sixty (60) geometric attribute pieces are spread out next to the gameboard to form a "bank." The beginning player selects any one of the attribute pieces and places it on the center darkened starred pentagon base.

RULES:

1. **Occupied Base:** A pentagon base is said to be occupied if it contains an attribute block (piece). At the beginning of the game the central pentagon base is occupied.

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2. **Alternating Turns and Piece Selection:** Players alternate taking turns. Each player's turn consists of two parts:
   a) selecting one attribute block from the bank and placing it onto one of the pentagon bases on the gameboard; and
   b) moving the scoring marker the appropriate number of steps along the track.

3. **Scoring Points to Move the Marker:** Players can score points by placing a selected attribute piece onto a pentagon base connected by a line to an occupied base. Each attribute piece differs from the other pieces in the set in at least one way or in as many as four ways. Each difference between an attribute piece on an occupied base and a selected piece placed on a base directly connected by a line to the occupied base scores one point for the player. The player moves the scoring marker the same number of steps along the track as the points obtained. A player must count up all differences between the selected piece placed on the gameboard and all adjoining attribute pieces on occupied bases directly connected by lines to the selected base. Scores of ten points or more can be obtained in this way.

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4. **Announcing the Score:** Players must state the number of spaces they are going to move before they move the scoring marker. Specific attribute differences need not be stated, only the total score. If the score is not stated, a player may be challenged (see Rule 16) and lose a turn.

5. **A Piece Laid is a Piece Played:** Once a player has picked up a piece from the bank it must be placed onto the gameboard. And, once a player is no longer touching a piece placed onto the gameboard it may not be moved to another base.

6. **Minimum Score:** A minimum score of one (1) must be obtained by placing a selected attribute piece onto a base which is connected to an occupied base. Attribute pieces may not be placed on bases which are not directly connected by a line to an occupied base.

7. **Bumping:** Should a player's scoring marker land on a blank track space occupied by the opposing player's marker, the opponent's marker is moved back five spaces. Markers on the first four blank spaces are bumped back to the starting position. Should this occur on one of the blank spaces beyond space 55, the player can choose in which direction the opponent's marker is to be moved.

8. **Numbered Track Spaces Are Safe:** Numbered track spaces can be occupied by the scoring markers of both players. These spaces are considered safe so that a player can not send back an opponent's marker by landing on the same numbered space of the track.

9. **Pencil and Paper Optional:** A player may use pencil and paper to add up all the points accumulated in a given turn if need be.

10. **Beginning a Turn:** A player's turn begins when the opposing player has moved the scoring marker into the final position for that turn and releases hold from the marker.

11. **End of Turn:** A player's turn ends when the scoring marker is moved into the final position for that turn and the player's hand is released from the marker.

12. **End of Game:** The game has ended when:
    a) the last unoccupied pentagon base has been covered by a selected attribute piece and a player has completed a turn;

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b) a player's scoring marker lands on the space marked fifty-five (55).

13. **Scoring 55 And Reversing Movement of Markers:** Should a player's scoring marker go beyond the space marked fifty-five (55), its direction of movement can be reversed in a later turn. A marker's direction of movement may not be reversed within the same turn.

14. **Track Limits And Direction of Movement:** A scoring marker may not be moved or bumped (see Rule 7) beyond the limitations of the track. Once a scoring marker has gone past space 55 it can be moved in either direction during subsequent turns. A scoring marker may not backtrack within the same turn e.g., it may not be moved five spaces forward and two back for a total of seven within the same turn.

15. **Win/Tie:** A player has won the game if after ending the game by landing on the space marked fifty-five (55), the opposing player is not able to land on space fifty-five (55) on the the next turn. If the opposing player succeeds in also landing on space fifty-five (55), a tie is declared. If the game has ended and neither player has succeeded in landing on space fifty-five (55), a tie is declared.

TOURNAMENT RULES:

16. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge. To indicate that a challenge is being made a player must announce "challenge." A Mathematics Pentathlon® official must rule on this challenge. In order to do so an official time out will be granted and the official will ask the challenger to state the nature of the challenge. The official must rule on whether the challenge as stated by the player is correct or incorrect. If the challenge is verified, the opposing player must move the scoring marker back to the position it occupied before the turn began and the selected piece must be returned to the bank. In effect, the challenged player has lost a turn. If the challenge is not verified and the opponent is found to have completed the turn accurately, the challenger loses a turn and the player who was challenged can proceed to complete another turn.

17. **One Minute Time Limit:** Each player must complete both parts of a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon® official will restore the gameboard to where it was at the beginning of that turn and the player will forfeit that turn. The third violation of this rule results in

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a forfeiture of the game. Players may not challenge each other over this rule at the Mathematics Pentathlon® . An official at the tournament will decide whether or not this rule is being violated.

18. **Game Time Limit:** At the Mathematics Pentathlon® , if the thirty (30) minutes of game time has run out before either player has ended the game, a tie is declared. If a player has picked up an attribute block from the bank and is in the process of placing it onto the gameboard when time is called, the player will be allowed to complete that turn. Should the player succeed in landing on space fifty-five (55), the opposing player will be granted an additional turn. Sufficient time for Rule 15 to be exercised will be granted. If game time is called and a player has not yet selected an attribute piece from the bank, the game has ended.

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GAMEPIECES FOR PAR 55

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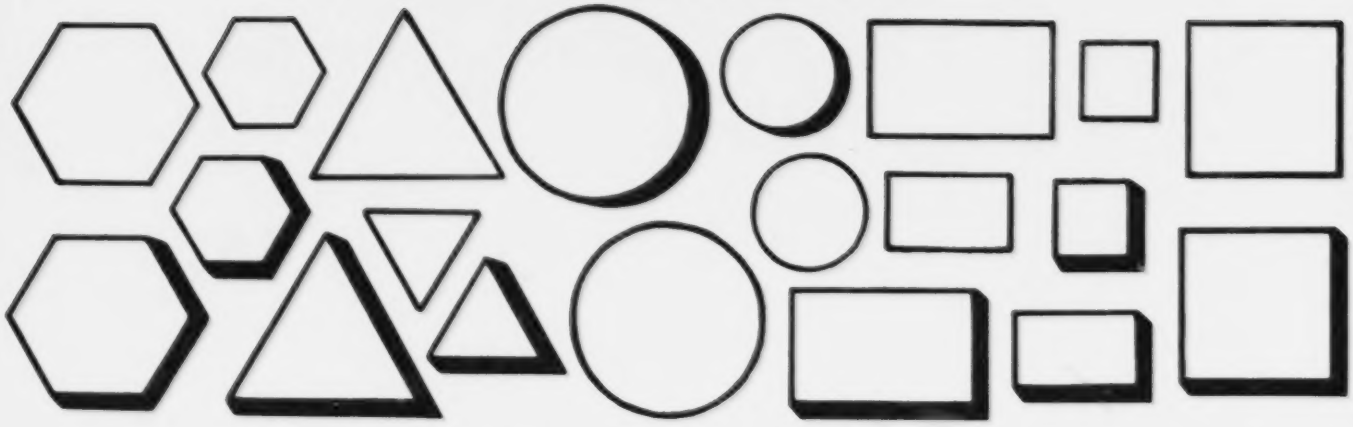
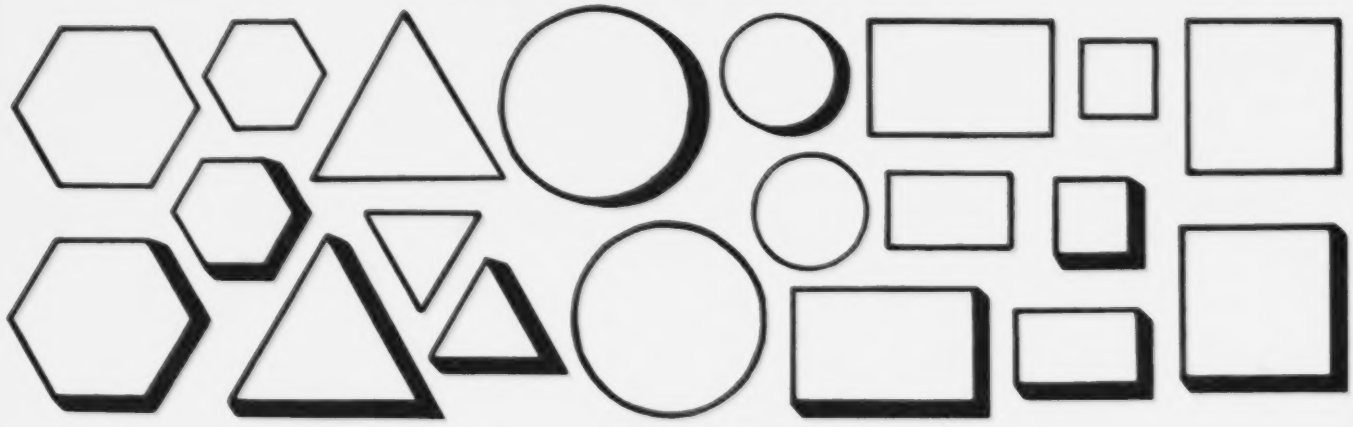
COLOR THESE PIECES RED



COLOR THESE PIECES YELLOW



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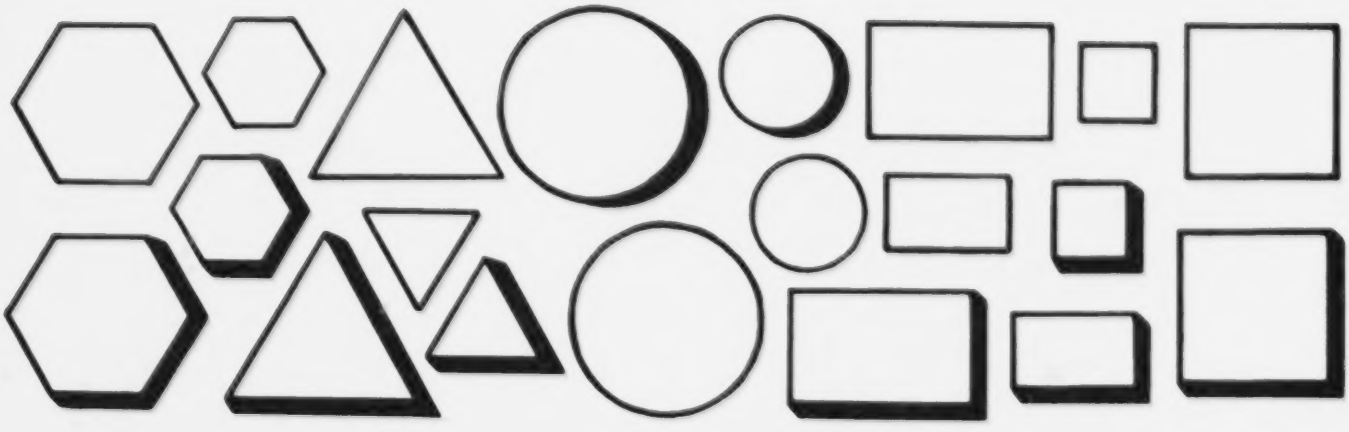

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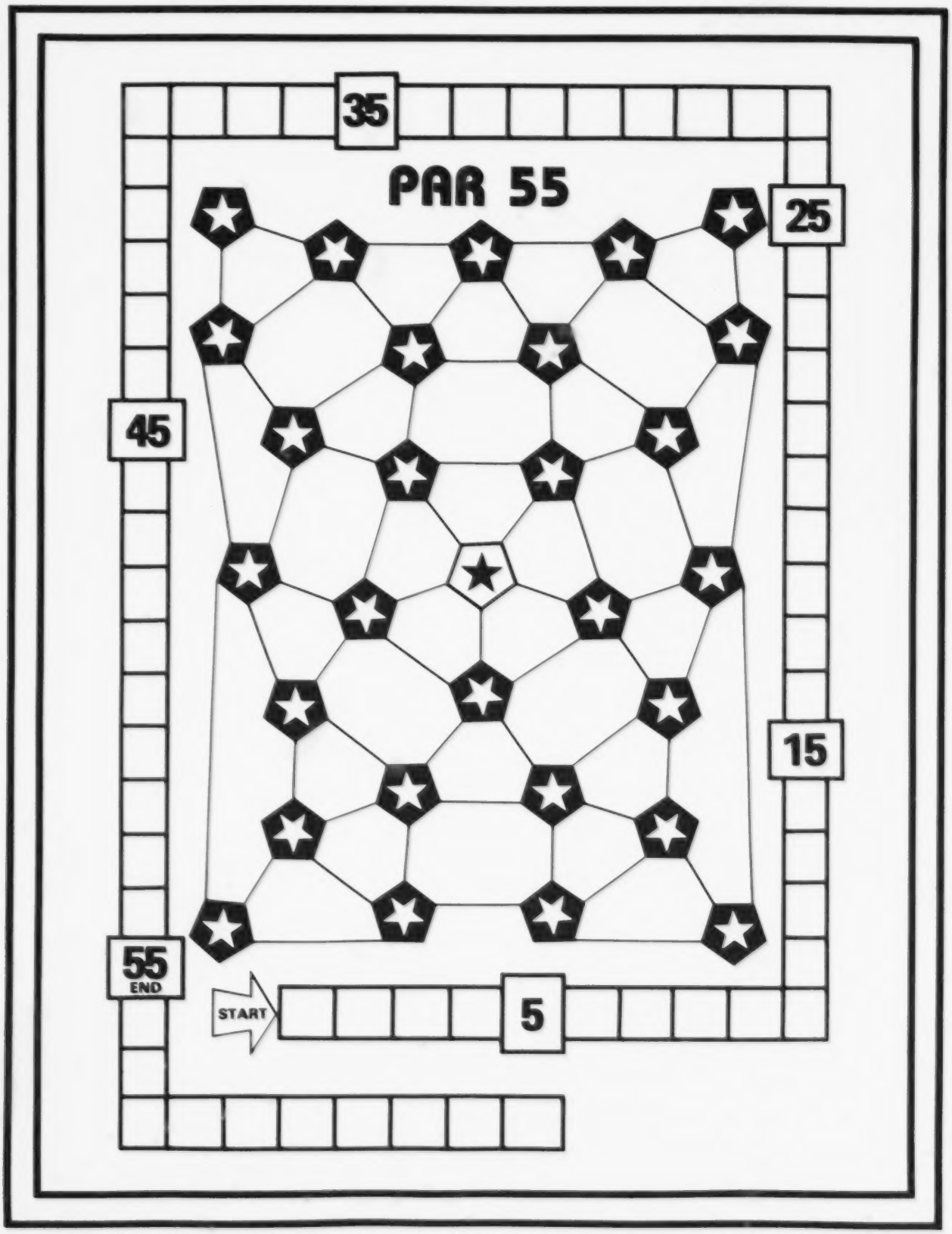
This page can be used to make an overhead transparency.



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KWATRO-SINKO

Created by
Dr. John C. del Regato

This Mathematics Pentathlon® event is a computational alignment game. It is played with five (5) even numbered markers of one color and five (5) odd numbered markers of a different color. Players must use their spatial reasoning to align the appropriate values and their computational reasoning to add and subtract the values to obtain a result of four (4) or five (5). The total of four (4) or five (5) is obtained by adding the values of like color and subtracting the value of the marker of unlike color.

UNDERLYING MATHEMATICS/SCIENCE: addition, subtraction, combinatorics, spatial reasoning; observation skills, deductive and inductive reasoning

MATERIALS: Official Mathematics Pentathlon® gameboard, five (5) markers labeled 0, 2, 4, 6, and 8 of one color, five (5) markers of a differing color labeled 1, 3, 5, 7, and 9

TIME: Total tournament playing time is 30 minutes. Each player has one minute to complete a turn. When first learning this game, the time limit should be longer.

GOAL: To win, a player must position exactly three markers in a straight connected line so that two markers are of one color and the third is of the opposite color. Also, the result of adding the numbers of like color and subtracting the number on the marker of opposite color must total 4 or 5. The player must correctly identify the winning path of exactly three markers totaling 4 or 5 in order to receive recognition as the winner. **Only three markers can be on the winning path.**

TO START:

A. Each player selects, without looking, a marker from a container holding all game markers. The player with the lowest value begins the game and is designated the EVEN player. This player can move only the even numbered pieces during the game. The opposing player is the ODD player and can only move the odd numbered markers.

B. All markers are placed on their starting positions as indicated on the gameboard.

RULES:

1. **Alternating Turns and Marker Movement:** Players alternate taking turns. During a turn, a player may move a marker along a straight line in a vertical, or horizontal, or diagonal direction. Only one marker may be moved during a player's turn. The marker may be moved only

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one space forward, backward, sideways, or diagonally as the player desires, provided the path is not obstructed by other markers. Markers may not "jump over" other markers. A player may only move markers of their own color.

2. **Moving Markers Off Starting Positions:** Both players must move their five markers off the starting positions during the first five rounds. No marker can be moved a second time until all five markers are moved from their starting positions. No win can be declared until all five of each player's pieces have been moved out of their starting positions.
3. **Moving a Touched Marker:** Once a player has touched a marker, that marker must be moved to complete a turn.
4. **Beginning a Turn:** A player's turn begins when an opponent has moved a marker to a new position and has released touch from the marker.
5. **End of Turn:** A player's turn ends when the player has moved a marker to a new position and has released his or her hand from the marker.

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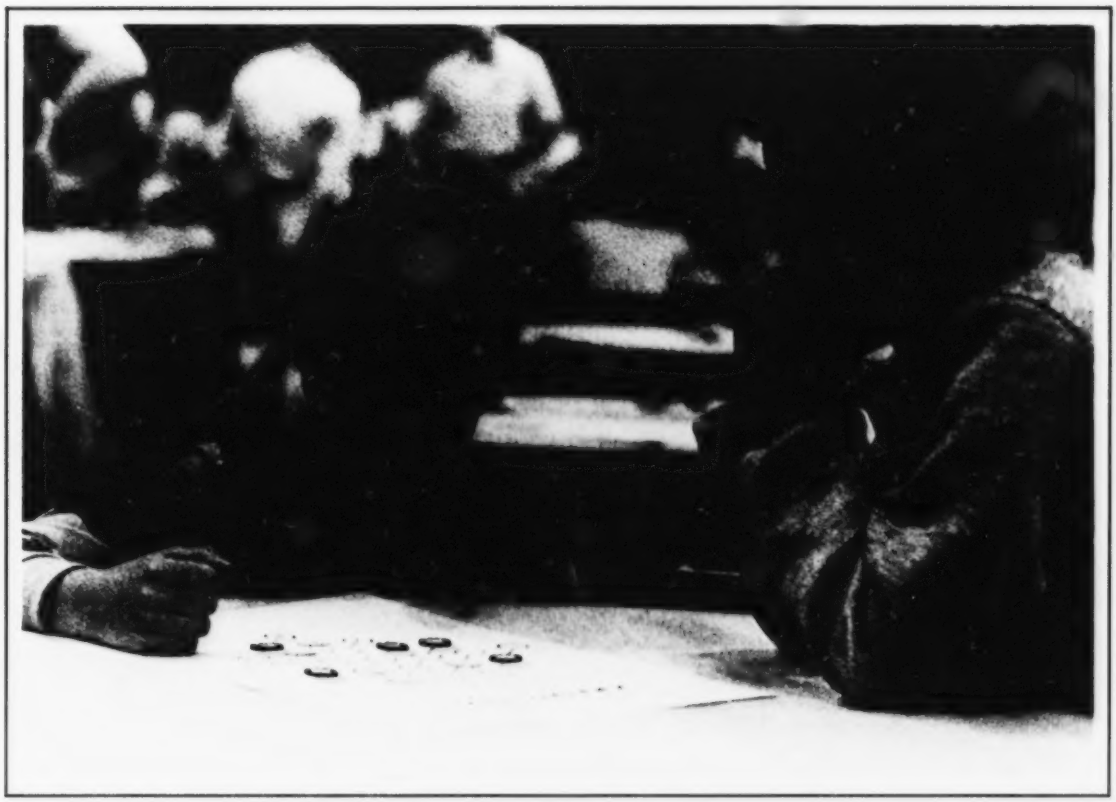

6. **Win:** To win a player must position exactly two markers of one color (not necessarily the player's color) and a third of the opposite color in a straight connected line. These markers may be in consecutive spaces or more than one space apart from each other, but **only three markers can be on the winning path**. A further condition must be met by the three markers on the winning path. When the numbers appearing on the markers of the same color are added together and the number on the marker of opposite color is subtracted from this sum, the resulting total must be either 4 or 5. For example 4 + 6 − 5 = 5 or 1 + 5 − 2 = 4. The player constructing a winning path must announce it as such before releasing touch of the marker and ending a turn. The player must correctly identify the winning total by stating the number sentence. Failure to do so may result in the opponent moving a marker and declaring a win. A player may claim an unclaimed winning path by moving a piece into another position on the gameboard and announcing the winning path before the end of a turn.

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TOURNAMENT RULES:

7. **Challenges:** If a player violates any of the preceding rules, the opposing player may issue a challenge at the end of the player's turn and before touching a marker. To indicate that a challenge is being made a player must announce "challenge." A Mathematics Pentathlon® official must rule on this challenge. In order to do so an official time out will be granted and the official will ask the challenger to state the nature of the challenge. The official must rule on whether the challenge as stated by the player is correct or incorrect. If the challenge is found to be correct, the gameboard will be restored to where the markers were positioned at the beginning of the challenged player's turn and the challenger will begin a turn. If the challenge is found to be incorrect, the challenger will forfeit a turn.

8. **One Minute Time Limit:** Each player must complete a turn within one minute. If a player fails to complete a turn within one minute, a Mathematics Pentathlon® official will restore the gameboard to where all markers were positioned at the beginning of that turn and the player forfeits that turn. The third violation of this rule results in a forfeiture of the game. Players may not challenge each other over this rule at the Mathematics Pentathlon® . An official at the tournament will decide whether or not this rule is being violated.

9. **Game Time Limit:** At the Mathematics Pentathlon® , if the thirty (30) minutes of game time has run out before either player has declared a win, a tie is declared. If a player has touched a marker and is in the process of moving it when game time is called, the player will be allowed to complete that turn. If game time is called and a player has not touched a marker for movement, the game has ended and a tie is declared.

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GAMEPIECES FOR KWATRO-SINKO

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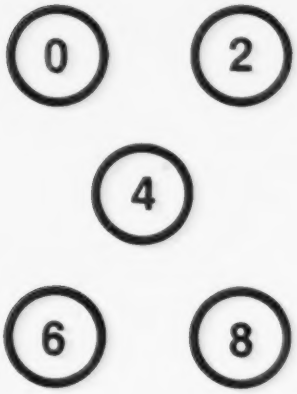
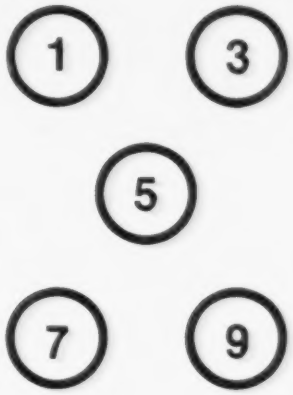
Color these markers RED.



Color these markers BLUE.



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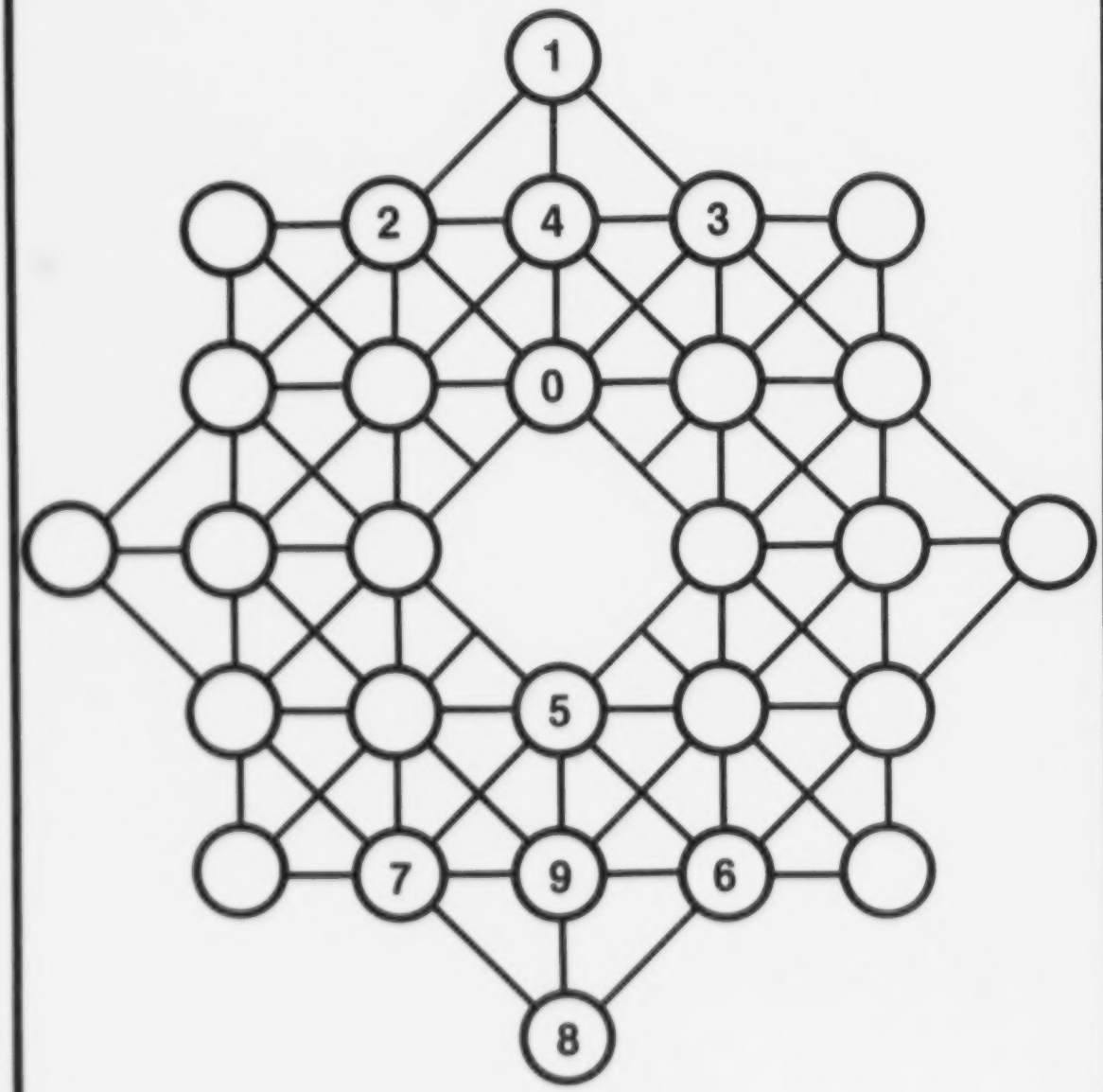
KWATRO-SINKO



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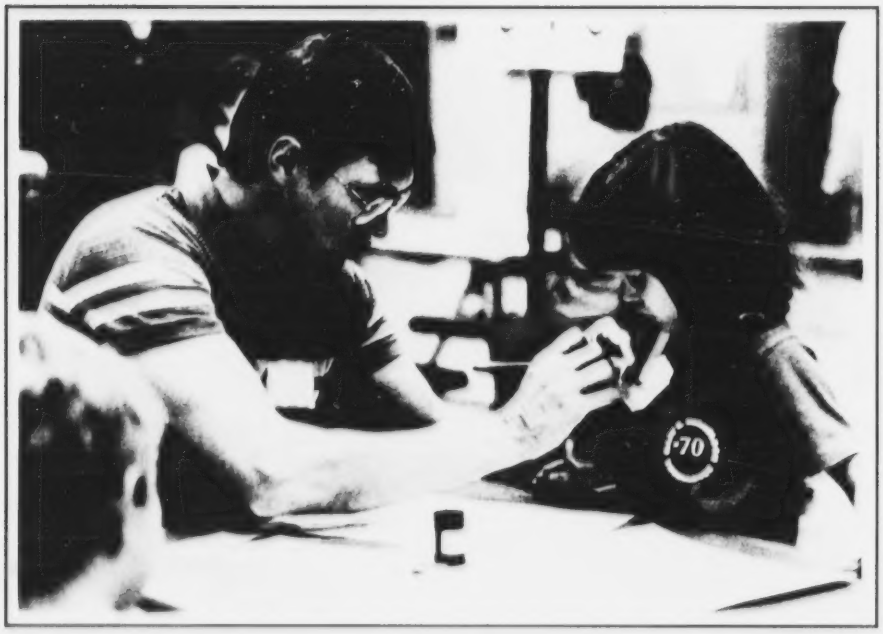

Based on a point system, the Mathematics Pentathlon® celebrates the accomplishments of ***many*** *mathletes. Regardless of the outcome, all participants are considered "winners". One only "fails" when one does not attempt to grow. In this attempt an individual may discover that an opponent contributes other insights that one did not consider. Indeed* ***real learning*** *has just been experienced!*

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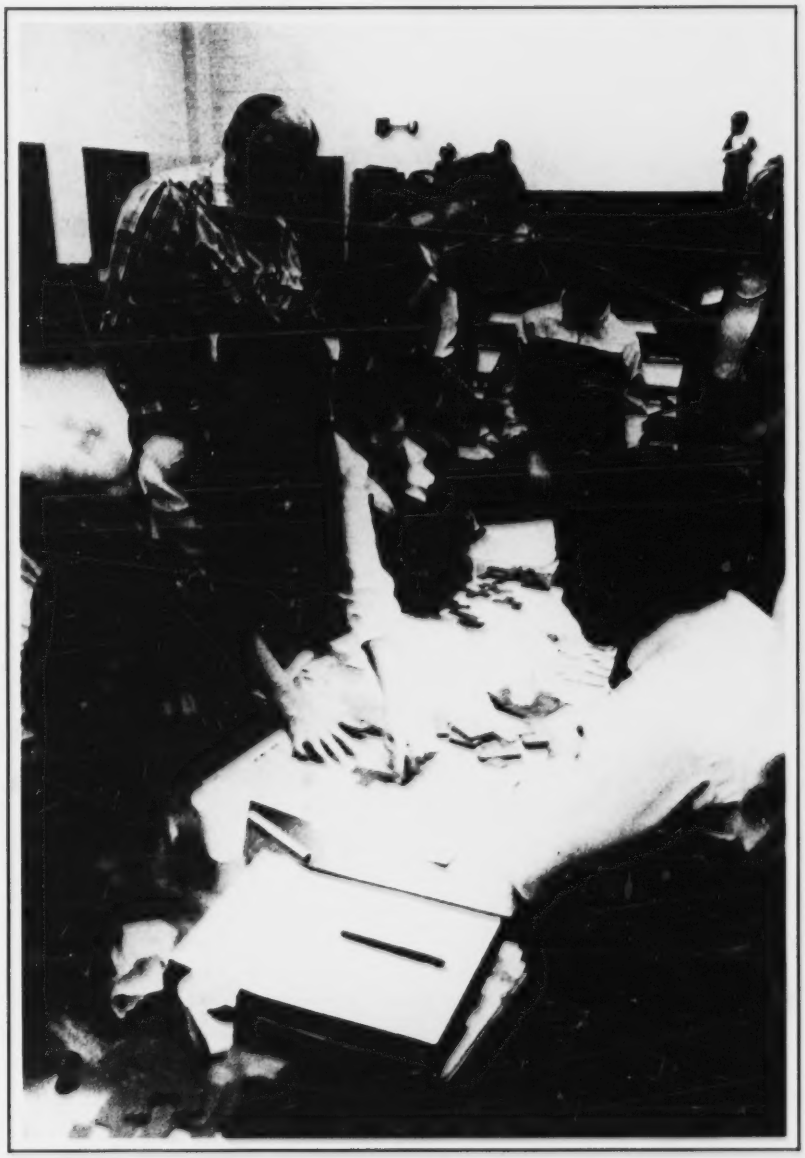

Orientation of parents, teachers, and administrators.

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Paula Minton
One of our star volunteers.

The Pentathlon Institute offers Mathematics Pentathlon® orientation sessions or special in-service sessions on teaching Mathematics Experienced-Based Approach (MEBA™). For further information please contact:

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National Director, Mathematics Pentathlon®

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